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A Duke Energy Company

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DATE: March 24, 1998

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: McGuire Nuclear Station, Unit 2
Docket No. 50-370
Licensee Event Report 370/98-01, Revision 0
Problem Investigation Process No.: 2-M98-0534

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a) (1) and (d), attached is Licensee Event Report 370/98-01, Revision 0, concerning a Reactor Trip on Unit 2 caused by a main turbine-generator voltage regulator failure. This report is being submitted in accordance with 10 CFR 50.73 (a) (2) (iv). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

H. B. Barron, Jr.

MTC

Attachment

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1144

NRC FORM 366 U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 04/30/98

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
McGuire Nuclear Station, Unit 2	05000 370	1 OF 7

TITLE (4) Reactor Trip Caused by a Main Turbine-Generator Voltage Regulator Failure

EVENT DATE (5)			LER NUMBER (6)					REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR		SEQUENTIAL NUMBER		REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER(S) 05000
02	22	98	98	-	01	-	0	03	24	98	Unit 2	05000 370

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR (Check one or more of the following) (11)			
POWER LEVEL (10)	100	20.402(b)	20.405(c)	X 50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER AREA CODE
M. T. Cash	(704) 875-4117

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	
X6	TL	RG	C770	Yes *							

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT *(Limit to 1400 spaces, i.e. approximately fifteen single-space typewritten lines)* (16)

Unit Status:
Unit 2 was in Mode 1 (Power Operation) at 100 percent power.
Event Description:
On February 22, 1998 at 20:54 an automatic turbine trip occurred on Unit 2 due to a voltage regulator failure. A turbine trip with the Unit above 48 percent power automatically resulted in an automatic reactor trip.
Event Cause:
Failure of the Unit 2 main turbine-generator voltage regulator resulted in a Unit 2 turbine-generator trip. The failed component was a firing drawer circuit card. Further root cause of the failure is being investigated.
Corrective Action:
The failed component of the turbine-generator voltage regulator was identified and replaced. A root cause analysis is being performed. Any new conclusions from the cause analysis will be input into an evaluation of current plans for complete replacement of the voltage regulator system.

NRC FORM 366 *NPRDS no longer exists, the failure will be reported through EPIX

BACKGROUND:

The McGuire main turbine-generators [EIIS:TG] have an automatic voltage regulation system which utilizes a type WTA voltage regulator [EIIS:RG]. The voltage regulator includes a single shaft brush ground detection system, power drawers, logic drawer, and firing drawers. The regulator includes redundancy to minimize extreme generator fluctuations caused by single component failures.

The WTA voltage regulator for each unit was installed as original McGuire plant equipment. Current manufacture maintenance support is performed by Cutler-Hammer [EIIS:C770], Inc. under Westinghouse [EIIS:W120] contract.

In the late 1980's regulator equipment concerns due to heat related aging issues resulted in McGuire installing an environmental enclosure around the regulator equipment. The regulator is maintained in a 65 - 75 degree Fahrenheit operating environment. Since installation of the enclosure, McGuire has not experienced many of the industry temperature related failures.

The redundancy in the regulator design enables the generator to have minimal output fluctuations as a result of failures. Normal recovery following a failure (where the generator is operating within it's capability limits) is to place the regulator in the "manual" mode for troubleshooting. At McGuire, previous regulator problems have been resolved quickly and the unit placed back in auto mode. The industry practice when a problem is more significant in nature is to keep the regulator in "manual" until the next outage.

During the past few years McGuire has had a few failures with various circuit cards and components in the regulators. The most recent failure occurred on McGuire Unit 1 on February 11, 1997. During this failure, voltage control was recovered without a turbine trip. McGuire initiated a root cause failure analysis through Problem Investigation Process 1-M-97-0491. The root cause was completed and provides a failure event analysis coupled with corrective actions to reduce voltage regulator failures. A brief summary of related conclusions and completed corrective actions are further detailed.

There are three main failure types experienced with the regulators.
1) Failure of the motor operated potentiometers,
2) Circuit board failures (including complete drawer and connection problems), and
3) Failure of shaft ground brush circuit.

Corrective actions from the prior root cause includes (a) development of a voltage regulator equipment replacement plan, and (b) increasing the preventative maintenance (PM) cycle on the McGuire voltage regulators to every refueling outage.

During the prior completed refueling outage (2EOC11) as part of the PMs, the firing drawers were sent to the OEM (Cutler-Hammer) and were refurbished to meet manufacturer's specifications.

The voltage regulator equipment replacement plan has been submitted for selection as part of the planned modification process.

EVALUATION:

Description of Event

On February 22, 1998 at 20:45 voltage and current alarms were received on Unit 2 for 6.9 kV [EIIS:EPA] and 4 kV [EIIS:EPC] buses [EIIS:BU] and the turbine-generator per the Operator Aid Computer [EIIS:CU]. The most prevalent alarms [EIIS:EA, JA, IA] were +800 MVARS, a 0.8 power factor, and 150 exciter field amps for the Unit 2 turbine generator. Operations took manual action to reduce VARS using voltage adjust. The voltage adjust and base adjust minimum lights were lit. VARS response was a very slow reduction.

The control room crew referred to the turbine generator capability curve and determined that the generator was operating outside the limits of the curve. When the Operations Shift Manager arrived in the control room, he determined that the voltage regulator was not providing acceptable automatic control. He directed the Operator at the Controls to place the voltage regulator in the test position (manual) and use the base adjust to lower output voltage. After placing the voltage regulator switch in test position, the base load adjuster button was depressed resulting in VARS and balance volts slowly dropping. As the power factor approached unity, the rate of voltage drop increased. The Operator at the Controls attempted to raise voltage using the base adjust. The response of the base adjust was too slow to prevent a protective relaying turbine generator trip.

The B Diesel Generator [EIIS:DG] unexpectedly received a signal to autostart. Prior to the reactor trip, the generator load transient resulting from the voltage regulator failure induced a substantial decrease in the voltage on the 4160 bus. With rapidly decreasing

generator MVAR load, voltage decreased on both 4160 volt buses. Both 2ETA and 2ETB sensed degraded grid conditions on each phase. Due to the existing plant configuration, the B train was carrying more load than the A train and bus voltage was approximately 200 volts lower than the corresponding A train. Due to this system alignment, only 2ETB reached the under voltage setpoint on all three phases, resulting in an autostart of the B Diesel.

The generator regulator output that was experienced resulted in an apparent loss of excitation to the machine. The Loss of Field (40) relay initiated and tripped the generator zone lockout relays (86GA and 86GB). These lockouts initiate a trip of the generator field breaker (41) and both generator circuit breakers (GCB 2A and GCB 2B).

On February 22, 1998 at 20:54 a Unit 2 automatic turbine trip was initiated due to the generator protective relay actuation. A turbine trip with the Unit above a 48 percent power permissive automatically resulted in tripping the reactor [EEIS:RCT]. The motor driven Auxiliary Feedwater System [EIIS:BA] pumps were started manually, in response to decreasing steam generator levels, at 20:59:04. At 20:59:08 the turbine driven Auxiliary Feedwater pump automatically started on two out of four steam generators [EIIS:SG] lo-lo level set point. At 21:08:45 the steam generator levels had recovered and the turbine driven Auxiliary Feedwater pump was secured.

Sequence of Events

20:45 Began receiving Unit 2 high voltage and current alarms.

The setpoint for the generator voltage auto-adjusted to the low range of the setpoint. The base adjust for the generator auto-adjusted to the 0% load.

The Reactor Operator took manual actions to control generator by depressing lower on the voltage adjust switch.

The Reactor Operator placed the voltage regulator switch in the "test" position under guidance from the Operation Shift Manager and control room crew. Due to the base adjust auto-adjusted minimum setting, the exciter field voltage went to a minimum value. Voltage decreased rapidly until the turbine-generator tripped due to protective relaying.

20:54:03.047 Diesel generator 2B starts on black out logic.

20:54:03.416 Turbine trip above permissive 48% load causes reactor trip. Both reactor trip breakers open within required time. Main Feedwater System pumps automatically reduce speed.

20:59:04 Reactor Operator manually starts the motor driven Auxiliary Feedwater System pumps due to falling steam generator level.

20:59:06 Steam generator 2C reaches its lo-lo reactor trip set point.

20:59:08 Steam generator 2A reaches its lo-lo reactor trip setpoint initiating start of the turbine driven Auxiliary Feedwater System pump.

21:08:45 Steam generator levels recover. The turbine driven Auxiliary Feedwater System pump is secured.

All Engineered Safety Feature systems responded as expected and no significant difficulties were noted during trip recovery. Reactor parameters were at the nominal no load values following the reactor trip.

Conclusion

This event did not result in any uncontrolled releases of radioactive material, personnel injuries, or radiation overexposures.

The voltage regulator failure was unusual in that previously observed failures of firing drawer circuit cards have not resulted in turbine-generator trips. Normally a failure would result in reduction of the firing drawer impulse signal. The dominant redundant firing drawer supplies the voltage regulator impulse. During the February 22, 1998 failure, the circuit card failure apparently increased the pulse output of the firing drawer and initially drove main generator output voltage high. The automatic response of the regulator and the actions by the operator placing the regulator in manual resulted in the generator regulator response that initiated the loss of field protection and the unit trip. The manufacture, Cutler-Hammer is currently examining the failed circuit card to further determine the cause and logic for this failure behavior.

Review of the Operating Experience Program (OEP) and PIP databases for the past 24 months revealed that there have been no events involving

failure of a main turbine-generator voltage regulator that have resulted in a reactor trip. Therefore, this event is considered to be non-recurring.

CORRECTIVE ACTION:

Immediate

1) A reactor trip investigation team was formed and completed the reactor trip investigation.
2) Unit 2 turbine-generator voltage regulator trouble-shooting identified and replaced one of the six circuit cards in one of the two firing drawers.
3) A turbine-generator voltage control trouble-shooting plan was developed and executed which included a two hour turbine-generator run at generator no load prior to on-line operation.
4) Engineering Guidance to Operations was provided for operator response to generator operation outside of the capability curve.

Subsequent

1) A recorder remained installed during the first two weeks of on-line operation to provide additional voltage regulator performance monitoring.

Planned

1) The root cause for the turbine generator regulator failure will be completed after the OEM analysis of the suspect failed card has been completed.
2) The evaluation for replacement of the turbine-generator voltage regulator has been submitted for selection as part of modification process. The selection process will factor the current event into the decision for modification selection including installation scheduling.
3) Operations procedures/training will be revised to incorporate engineering guidance for operation outside the main generator capability curve.

SAFETY ANALYSIS:

Based on this analysis, this event is not considered to be significant. At no time were the safety or health of the public or plant personnel affected as a result of the event.

During the event, feedwater flow to the Steam Generators was maintained by the Auxiliary Feedwater system, ensuring adequate residual and decay heat removal.

In summary, the units experienced conditions that have been analyzed in Final Safety Analysis report (FSAR) Section 15.2.3, Turbine Trip, or in the Control Room Dose Analysis. Emergency core cooling and emergency power were not required.

CATEGORY 1

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